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THE LARVA AND PUPA OF THE PREDACEOUS
WATER BEETLE, *HYGROTUS SAYI*
(COLEOPTERA: DYTISCIDAE)

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The purpose of this study is to describe the larva and pupa of *Hygrotus sayi* J. Balfour-Browne and to report some observations made on the bionomics of the species.

In 1969, the junior author collected numerous adults and larvae of aquatic beetles from a farm pond near Moscow, Latah County, Idaho. Larvae and assumed adults of a species of Dytiscidae were found abundantly in algal mats of *Mougeotia* sp. Specimens were sent to Mr. Hugh B. Leech (California Academy of Sciences) who identified the adults as *H. sayi* and suggested that the larvae probably were the immature stage of *sayi*. Establishment of the identity of the larvae was desirable because the immature stage of *H. sayi* was undescribed.

The pond (Fig. 1), on the Floyd W. Trail property, covers an area of 1½ acres and is 12 to 13 feet deep at its maximum. In 1969, *Hygrotus* larvae were numerous about 6 feet from shore in mats of a filamentous green alga, *Mougeotia* sp. These mats were about 12 inches thick and floating in water 3 feet deep. In 1970, larvae were found again in mats (Fig. 2) of *Mougeotia* intermixed with *Spirogyra* sp. and *Lemna* sp. among a stand of *Typha latifolia* Linn. These mats were located 1 to 2 feet offshore in water 3 to 12 inches deep. In both years larvae were found only in the upper 4 or 5 inches of the mats, perhaps being limited to this portion by a need for ready access to the water surface for respiration. Early



FIG. 1. Biotope, Trail's Pond, Moscow, Latah County, Idaho.

instar larvae first appeared in early June and peaked in abundance about a month later. Larvae in late instars were prevalent throughout July and peaked at midmonth. No larvae were found after mid-August.

Larvae collected for rearing were placed individually or in groups of 2 to 4 specimens in a small petri dish (35 mm) containing water which was in turn enclosed in a larger container. The space between the two containers was filled with soil which afforded a pupation site. These rearing chambers were maintained at room temperature. Specimens being reared were fed cladocerans and small amphipods daily or allowed to cannibalize weaker dytiscid larvae.

Last-instar larvae taken to the laboratory for rearing pupated from 3 to 15 days after collection. Table 1 shows the results of eight rearing attempts.

Two larvae were observed constructing pupal cells. Each specimen labored about 5 hours, moving about in its chamber and compacting the soil. Also, the larvae produced a milky yellow fluid which appeared to help cement together the soil particles. The finished cells were oval with smooth inner walls. After the pupal cell was completed, the larva remained



FIG. 2. Habitat niche, algal mat in Trail's Pond.

quiscent (but reacted actively if disturbed) for about 10 hours before transformation. The pupa freed itself from the larval exuvium by wriggling. The abdomen was freed first and then the thorax and head. The shed exuvium remained in the pupal cell. If the exuvium is retrieved promptly it may be used for descriptive purposes.

TABLE 1. Rearing data for pupation of *Hygrotus sayi*

Larva No.	Larva collected	Date pupated	Date preserved	Date eclosed	Days in pupation
1	VII-20-70	VIII- 1-70	VIII- 3-70	—	—
2	VII-27-70	VIII- 2-70	VIII- 2-70	—	—
3	VII-27-70	VIII-11-70	VIII-12-70	—	—
4	VII-29-70	VIII- 4-70	VIII- 5-70	—	—
5	VII-27-70	VIII- 2-70	—	VIII- 4-70	2-3
6	VIII- 7-70	VIII-10-70	—	VIII-15-70	5-6
7	VIII- 7-70	VIII-11-70	—	VIII-15-70	4-5
8	VIII- 7-70	VIII-13-70	—	VIII-16-70	3-4
Average days from pupation to eclosion					3½-4½

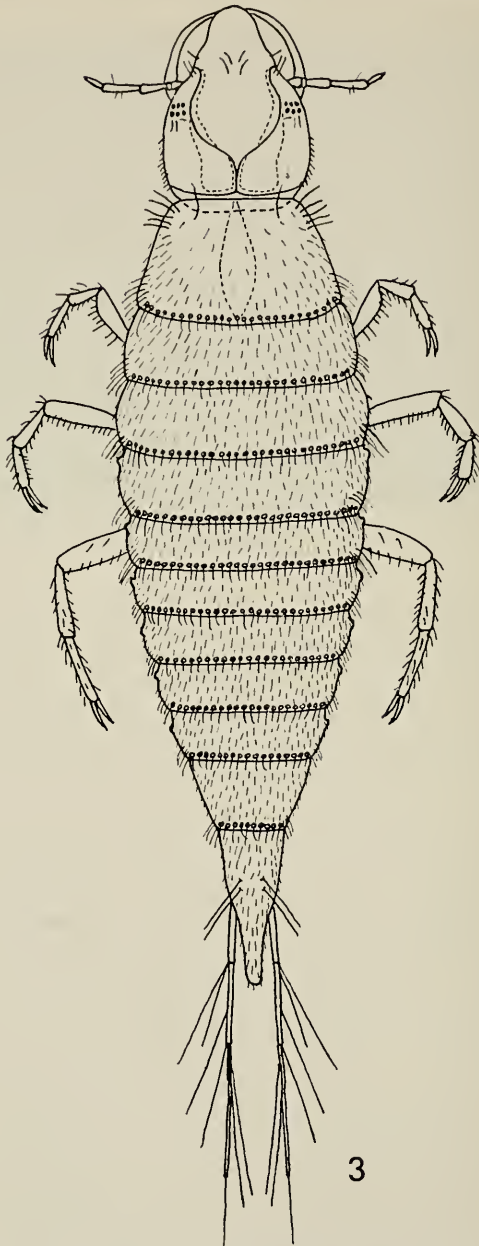


FIG. 3. *Hygrotus sayi* Balfour-Browne, last-instar larva, habitus view.

Three pupae, not included in Table 1, which died in the process of shedding the larval exuvium were preserved to illustrate this stage of ecdysis. In these specimens, the larval exuviae are split along the ecdysial cleavage line on the head, the pro-, meso-, and metathoracic segments, and the first abdominal segment.

Last-instar larva: Length (including cerci), 5.6 mm; greatest width, 1 mm. Color of dorsal surface of head and thoracic segments yellowish brown; abdominal segments reddish brown. Head with distinct darker brown maculae adjacent to base and frontal arms of ecdysial cleavage line and along posterolateral angles. Ventral surface, legs, cerci, and appendages of head creamy yellow to yellowish brown. Body sub-cylindrical and elongate (Fig. 3).

Head pyriform. Nasale broad, elongate; laterally notched at mid-length; toothed ventrolaterally behind notch (Fig. 4); with 3 or 4 denticles in front of each notch; anteroventral margin bearing fringe of fine setae; dorsal surface smooth and bearing 2 long setae behind each notch and 1 seta in front of each notch. Ecdysial cleavage line distinct, forked a short distance in front of occipital ridge near base of head; frontal arms terminating mesad of and in front of antennae. Occipital ridge dark brown, extending transversely across head near base. Ocular area with 6 ocelli arranged in an ellipse; anterior 3 ocelli slightly closer than posterior 3; ocelli about equal in size. Temporal setae 10 to 12. Antenna (Fig. 5) cylindrical, 4 segmented; basal segment broadest, shorter than 2nd or 3rd segment; 3rd segment longest; 4th segment shortest; acicular seta on apex of 3rd segment shorter than and adjacent to 4th segment. Ventral surface of head smooth; with 5 or 6 slender setae behind base of each mandible; gula distinct, elongate; posterior tentorial pits midway between base of head and mandibular articulation. Mandible long, falciform (Fig. 6). Maxillary palpus (Fig. 7) slender, elongate, 4 segmented; basal segment shortest, second segment longest and slender; all segments glabrous. Stipes subquadrate and bearing 1 short seta on mesal surface. Labium (Fig. 8) small, rectangular, with 2 long slender setae on dorsal surface at each anterolateral angle behind insertion of labial palpus; ligula absent; labial palpus slender, 2 segmented, basal segment with 1 ventrolateral seta at midlength and 1 seta medially at apical fifth, ultimate segment with 1 medial seta near base and 1 dorsal, 1 lateral, and 1 ventral seta near apical third.

Pronotum trapezoidal, wider basally; with 4 or 5 long and several short setae near anterolateral angle, 2 or 3 long and several short setae along lateral margin, 5 or 6 long and several short setae at posterolateral angle, numerous long and short setae along basal margin, and numerous short setae scattered over surface. Mesonotum slightly wider than and about half as long as pronotum, with numerous setae along lateral and posterior margins and scattered over surface; setae at

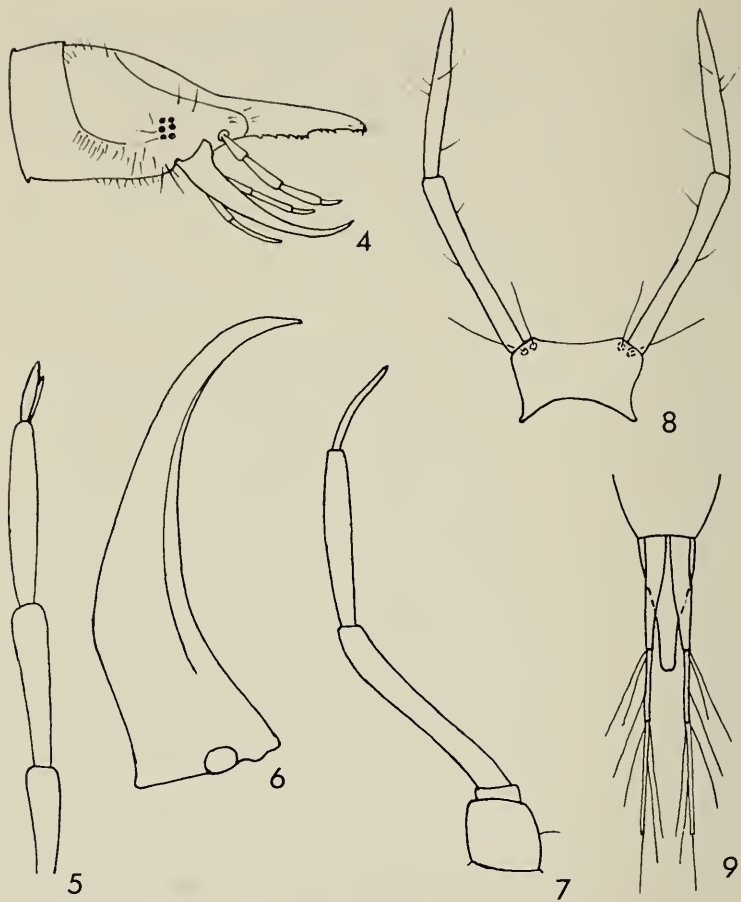
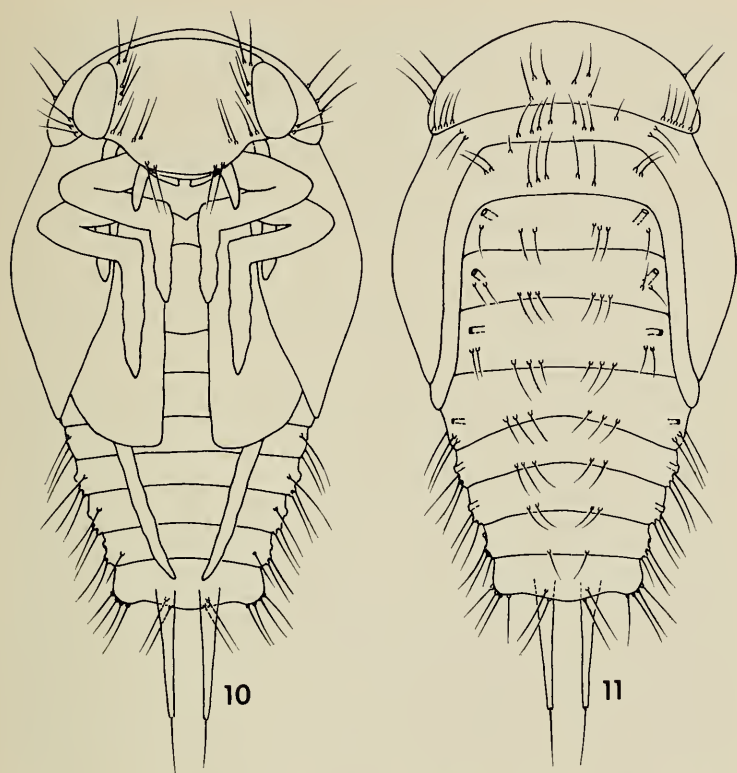


FIG. 4-9. *Hygrotus sayi* Balfour-Browne, last-instar larva: 4, head, lv; 5, antenna, dv; 6, mandible, vv; 7, maxillary palpus, vv; 8, labium, vv; 9, last abdominal segment and cerci, vv. lv = lateral view; dv = dorsal view; vv = ventral view.

posterolateral angles longest; spiracular opening in pleural region below each anterolateral angle of sclerite. Metanotum slightly wider than and about as long as mesonotum; setation similar to mesonotum.

Legs elongate, 5 segmented; coxa long; trochanter about one-third as long as coxa; femur as long as tibia and tarsus combined; tarsus with 2 elongate claws, inner claw slightly more robust and slightly longer than outer claw. Coxa with 1 short seta ventrally at base and 2 small



FIGS. 10, 11. *Hygrotus sayi* Balfour-Browne, pupa: 10, ventral view; 11, dorsal view.

setae and 1 stout long seta on ventrolateral angle and 5 or 6 long setae on dorsolateral angle. Trochanter with 3 small setae on ventral surface. Femur with 3 small setae on upper edge, 1 basal, 1 medial, and 1 apical; ventral surface with 4 long, stout setae; anteroventral angle with 8 or 9 short, stout setae; posteroventral angle with 12 or 13 small, robust setae. Tibia with 3 stout setae on upper surface; ventral surface with 5 or 6 stout setae. Tarsus with 4 stout setae on upper surface and 4 on lower surface.

Abdomen of 8 distinct segments. Segments 1 through 6 with broad, distinct terga; pleural and sternal areas not sclerotized. Segments 7 and 8 completely sclerotized, ringlike. Terga of segments 1 through 7 with setae on lateral margins, across hind margins, and scattered over surface. Segment 8 setose over surface, prolonged posteriorly as a slender cone-shaped segment beneath which are 2 slender cerci (Fig. 9). Cerci

without secondary hairs; each cercus of 2 long slender articles; basal article with 3 long slender setae, 2 lateral at basal third and 1 dorsal at apical third; apical article with 3 long slender setae, 2 basoventral and 1 on apex. Lateral margins of abdominal segments 1 through 7 each with a spiracle. Mesopleural, metapleural, and pleural folds of abdominal segments 1 through 6 each with several long setae and numerous short setae. Abdominal segments with numerous short setae scattered over ventral surface.

Pupa: Length (including cerci), 2.6 mm; greatest width, 1.4 mm. Color creamy white except eyes dark reddish brown. Glabrous except for styli described below.

Head (Fig. 10) with 22 styli arranged as follows: 5 along dorsomedial margin of eye, 4 at lower anterior corner of each eye and 2 on each lateral corner of clypeus.

Pronotum (Fig. 11) with 20 styli arranged as follows: 2 on right anterolateral angle, 3 on left anterolateral angle, 5 on right posterolateral angle, 4 on left posterolateral angle and 3 on each side of median line on disc.

On the dorsum of the mesonotum, metanotum, and several of the abdominal segments, the styli are unequal in number on opposite halves of the pupa; therefore a numerical formula is used that gives the number of styli on the left and right side of the midline. The midline is indicated by a -M- between the number of styli. The styli are arranged as follows: mesonotum, 6-M-6; metanotum, 6-M-4; abdominal segment 1, 3-M-4; abdominal segments 2 through 4, 5-M-5; abdominal segment 5, 5-M-4; abdominal segment 6, 4-M-4; abdominal segment 7, 3-M-3; abdominal segment 8, 6-M-6.

Abdominal segment 9, mostly hidden by expanded 8th segment, terminates in 2 cerci longer than length of 8th segment; apex of each cercus bearing a slender elongate seta, one-third as long as cercus.

First through seventh abdominal segments each with a pair of lateral spiracles arranged as follows: segment 1 with large spiracle near anterolateral angle; segments 2, 3, and 4 each with large spiracle close to lateral margin near midlength; segments 5, 6, and 7 each with smaller spiracle in pleural area; spiracle of segment 7 very small.

Antennae directed posteriorly and lie against ventral side of wing pads of elytra. Front and middle femora extend outward at right angles from body axis and lie beneath elytral wing pads. First 2 pairs of legs with tibiae folded against femora; tarsi turned backward parallel with body axis. Hind femora and tibiae hidden between abdomen and pads of hind wings. Each hind leg with femora and tibiae not folded against each other; femora directed obliquely away from midline; tibiae directed obliquely toward midline; tarsi almost parallel with body axis.

Variation: The preceding description refers to a single plesiotype pupa. The number of styli on the four pupae varied considerably as follows: head, 20-22; pronotum, 20-30; mesonotum, 12 to 14; metanotum, 9 to 14; abdominal segment 1, 1 to 6; abdominal segment 2,

9 to 10; abdominal segment 3, 9 to 10; abdominal segment 4, 9 to 10; abdominal segment 5, 8 to 10; abdominal segment 6, 9 to 10; abdominal segment 7, 4 to 7; abdominal segment 8, 8 to 10.

Ecological notes: Other insects found in the algal mats with the adults and larvae of *H. sayi* were adults and larvae of the hydrophilid beetles, *Tropisternus lateralis nimbatus* (Say), *Enochrus californicus* Horn, *Enochrus piceus* Miller, *Helophorus lacustris* LeConte, *Helophorus brevipalpis* Bedel, *Helophorus* spp., and a ceratopogonid, *Bezzia* sp.

The predator relationships in the pond and especially in the algal mat have not been studied. However, the larvae of the hydrophilids listed above are voracious predators. In one instance, a larva of *Tropisternus lateralis nimbatus* was observed feeding on a larva of *H. sayi*.

An interesting association occurs between a peritrich protozoan *Zoothamnium* sp. and the larvae of *H. sayi*. Among 84 larvae examined, 77 or about 92 percent were infested with *Zoothamnium*. In all infestations the stalked protozoans were attached only to the ventral surface of the head of the larvae and near the base of the nasale in front of the buccal cavity. On two specimens, some of the protozoans were attached also to the bases of the maxillary palpi. It has not been established whether this is an example of commensal or mutual symbiosis or a phoretic relationship.

Taxonomic conclusions: Watts (1970) described the larvae of the following seven species of *Hygrotus*: *punctilineatus* (Fall), *tumidiventris* (Fall), *punctatus* (Say), *sellatus* (LeConte), *patruelis* (LeConte), *canadensis* (Fall), and *impressopunctatus* (Schaller). He stated that generic separation of the larvae of *Hygrotus*, *Hydroporus*, and *Deronectes* was impossible. We concur that with the very incomplete knowledge available regarding the larvae belonging to these genera, their separation is not now possible.

LITERATURE CITED

- WATTS, CHRISTOPHER H. S. 1970. The larvae of some Dytiscidae (Coleoptera) from Delta, Manitoba. Canadian Ent. 102:716-728.